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Surface chemical analysis — Depth profiling — Methods for ion beam alignment and the associated measurement of current or current density for depth profiling in AES and XPS

Analyse chimique des surfaces — Profilage d'épaisseur — Méthodes d'alignement du faisceau d'ions et la mesure associée de densité de courant ou de courant pour le profilage d'épaisseur en AES et XPS

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 201, *Surface chemical analysis*, Subcommittee SC 4, *Depth profiling*.

This second edition cancels and replaces the first edition (ISO 16531:2013), which has been technically revised.

The main changes to the previous edition are as follows:

— Table 1, in reference to 5.4: a comment has been added to mention the use of automated alignment routine.

— 5.3.2, 5.3.3 and 5.5.4: some descriptions in notes have been changed to body text.

— minor editorial changes have been introduced for clarity.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In surface chemical analysis with Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS), ion sputtering has been extensively incorporated for surface cleaning and for the in-depth characterization of layered structures in many devices and materials. Currently, ultra-thin films of < 10 nm thickness are increasingly used in modern devices and so lower energy ions are becoming more important for depth profiling. For reproducible sputtering rates and for good depth resolution, it is important to align the ion beam at the optimal position. This optimization becomes increasingly critical as better and better depth resolutions are required. It is not necessary to conduct a beam alignment routinely but it is necessary to align the beam when instrument parameters change as a result of, for example, replacement of ion-gun filaments or an instrument bake-out. During the beam alignment, care must be taken not to sputter or otherwise affect samples for analysis on the sample holder. Instruments have different facilities to conduct alignment and six methods are described to ensure that most analysts can conduct at least one method. Two of these methods are also useful for measuring the ion beam current or the current density – important when measuring sputtering yields and for measuring sputtering rate consistency. With commercial instruments, the manufacturer may provide a method and equipment to conduct the beam alignment. If this is adequate, the methods described here might not be necessary but could help to validate that method.

ISO 14606 describes how the depth resolution may be measured from a layered sample and used to monitor whether the depth profiling is adequate, properly optimized or behaving as intended. That method, from the instrumental setup to the depth resolution evaluation via in-depth measurement, is, however, time-consuming and so the present, quicker procedure is provided to ensure that the ion beam is properly aligned as the first step to using ISO 14606 or for more routine checking.

Surface chemical analysis — Depth profiling — Methods for ion beam alignment and the associated measurement of current or current density for depth profiling in AES and XPS

1 Scope

This document specifies methods for the alignment of the ion beam to ensure good depth resolution in sputter depth profiling and optimal cleaning of surfaces when using inert gas ions in Auger electron spectroscopy (AES) and X-ray photoelectron spectroscopy (XPS). These methods are of two types: one involves a Faraday cup to measure the ion current; the other involves imaging methods. The Faraday cup method also specifies the measurements of current density and current distributions in ion beams. The methods are applicable for ion guns with beams with a spot size less than or equal to 1 mm in diameter. The methods do not include depth resolution optimization.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18115-1, *Surface chemical analysis — Vocabulary — Part 1: General terms and terms used in spectroscopy*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 18115-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

For the purposes of this document, the following symbols and abbreviated terms apply.

A	Area of Faraday cup aperture
A_R	Raster area at a known orientation to the ion beam
A_0	Area of ion beam raster in sample plane
AES	Auger electron spectroscopy
B	Ion beam broadening parameter equal to ratio I_{outer}/I_{inner}
C	Current
CD	Current density
D'	Ion dose rate at the sample
F'	Ion fluence rate delivered by ion gun